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A NEW RACE OF EUPHYDRYAS CHALCEDONA DBLDY. & HEW. FROM ARIZONA. (RHOPALOCERA-NYMPHALIDAE).

BY CYRIL F. DOS PASSOS,

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For several years correspondents in Arizona and California have been sending out an *Euphydryas* taken at various localities in Arizona as "hermosa" which is obviously not that species. *Hermosa* Wright (1905, Butts. West Coast, p. 157, No. 179) was described from southern Arizona which may account in part for the misidentification. It is figured by the author (Plate XIX figs. 179, b, c) and does not appear to be rare in collections. An examination of the genitalia of the false "hermosa" shows that it belongs to the *chalcedona* group while the true *hermosa* according to Gunder (1929 Pan. Pac. Ent. VI: 1)* belongs to the *anicia* group. The nearest representatives of the *chalcedona* group to the new subspecies are *quino* Behr (1863, Proc. Cal. Acad. Sci. 3: 90) and *olancha* Wright (1905, Butts. West Coast, p. 150, Pl. XVIII, No. 160, b). The specimens under consideration are nearer to *quino* than *olancha* but differ from the former in both sexes by having considerable less white on the uppersides, especially on the ♀♀ and the secondaries of the ♂♂. This race would appear to warrant a name and it is proposed to call it in honor of Dr. A. B. Klots;

Euphydryas chalcedona klotsi n. ssp.

(Plate figs. 1, 2, 3 and 4)

Holotype ♂ 45 mm. fringes generally black and white but in holotype black, next a narrow black margin, then a reddish area crossed by black nervules, then a black area containing two parallel irregular rows of white spots, eight in number, the second on the inner row being hardly visible, then an irregular row of eight spots, the first very small and white, the next five larger and red and the seventh and eighth pale reddish white; outside the cell three white spots separated by black nervules, at the end of the cell a red line in a black area followed inwardly by a white bar across the cell, then a reddish spot surrounded by black, a small reddish white spot and black at the base of the wing. Below the cell, internally to the above mentioned, pale reddish white spots, a black area with a white spot. Secondaries, fringes black and white, then a narrow black margin, then eight red spots as above, internally a black area as above with only one row of seven white spots, followed by a row of seven red ones then a row of eight elongated spots, the first five being partly red and partly white and the others white, then at the costa a reddish spot bounded outwardly and at the base by black, the cell practically as above except that the second black spot has but a

* Anyone studying the genitalia of the *Euphydryas* must beware of Gunder's erroneous use of technical terms. The errors occur on the first half of page 2 and are as follows—"left" on lines 1 and 10 should read "right"; "uncus" on lines 1 and 9 should read "clasper." Without these corrections that portion of the paper is meaningless. The author knew what he wanted to say without being able to express it

few red scales, below that, a white and reddish white area; the basal portion of the hind wing is sparsely covered with black and white hairs. On the underside the markings are reproduced in the typical *Euphydryas* fashion, the primaries have a salmon flush except at the apex and part way from the apex along the costa and outer margin, all black markings are very much reduced on both wings and the red and especially the white areas are larger. The antennae are dull red, the club black with reddish shading. The thorax and head are bluish black, palpi white at base, the balance salmon. The abdomen is black with six reddish bands, on the underside it is white, the legs are salmon.

Allotype ♀ 50 mm. The markings on both sides are similar to the ♂ but the reddish areas on the secondaries are more extensive and the reddish white areas and even some of the white spots in the ♂ are entirely red in the ♀. On the underside, the black areas on the primaries are more extensive than in the ♂. The appearance of many ♀♀ on the upperside is rather dull and suffused.

The types and their disposition are as follows:

Holotype — ♂, Roosevelt Lake, Ariz., Mar. 30 (D. K. Duncan) and genitalia slide No. 68 (C. F. dos Passos).

Allotype — ♀, Superstition Mts., Ariz. same date and collector; both in the American Museum of Natural History.

Paratypes — 8 ♂♂, Roosevelt Lake, Ariz. Mar. 30 (6) Mar. 30, 1934 (1) Apr. 23, 1935 (1); 3 ♂♂, Superstition Mts., Ariz. Apr. 2 (1) no date (1) Mar. 30, 1934 (1); 1 ♂, Wheatfields near Globe, Ariz. Mar. 29, 1934; 2 ♂♂, San Carlos Lake, Ariz. Apr. 17, 1935; 3 ♀♀, Roosevelt Lake, Ariz. Mar. 30, 1934; 1 ♀, Roosevelt, Ariz. Apr. 23, 1935; 1 ♀, Superstition Mts., Ariz. Mar. 30. All collected by D. K. Duncan at altitudes of 2100 to 2500', 1 ♂, Roosevelt Dam, Ariz. Apr. 20, 1929; 1 ♀, Roosevelt Dam, Ariz. Apr. 20, 1929. One pair of paratypes each to the British Museum (Natural History), Paris Museum, Canadian National Collection, Los Angeles Museum, Academy of Natural Sciences, Carnegie Museum and U. S. National Museum. The remainder are in the collection of the author.

THE CHERMIDAE, (HOMOPTERA), OF ALBERTA.

BY E. H. STRICKLAND,
University of Alberta.

The only published records of Chermidae captured in Alberta, which we have been able to find, refer to *Psyllia americana* Cwfd., *Trioza varians* Cwfd.¹ both taken at Banff, and *Paratrioza cockerelli* Sule., which has been, in recent years, accidentally introduced into the province.

A few specimens, consisting of three or four species, have been represented in the University of Alberta collection for a number of years. These included a series of a species which we had tentatively identified as *P. cockerelli*. They were sent to us, in the early spring of 1928, from a greenhouse near Medicine Hat and were reported to be very abundant on tomatoes. This material was sent to two specialists for determination but it returned to us unnamed.

By 1934, the prevalence of "potato yellows" in a number of localities in Southern Alberta resulted in the definite identification of this species, both in

greenhouses and in the field, and the association of the potato disease with its presence². There can be little doubt but that it was brought into the province with infested greenhouse plants and that it escaped from the houses into the field.

It is very doubtful whether it can over-winter in the open here and it would appear that the persistent infestation of potatoes in Southern Alberta is due to annual escapes from infested greenhouses.

In 1936, a case of "yellows" was reported in a city garden in Edmonton. *P. cockerelli* was found to be abundant in this garden though, elsewhere in the city, neither the disease nor the Chermid could be found. Growing near the infested garden were tomatoes. No information could be obtained regarding their origin except that the seedlings had been purchased in the spring. We were, thus, unable to confirm our suspicion that they had been imported from an infested greenhouse in the southern part of the province. A careful survey of potato gardens around Edmonton in 1937 failed to reveal "yellows" or *P. cockerelli*. The latter appears to have been killed out during the winter.

Among the numerous specimens of *P. cockerelli* which were collected from the infested potatoes was a single specimen of *Triozza maura* Forst. Since this, apparently, breeds on *Salix* Spp. it would appear that its presence on potatoes was accidental. During the same year two further species were taken in large numbers on other vegetation which was being swept. This suggested that somewhat intensive sweeping of vegetation in the neighbourhood of Edmonton might add a few records to the species known to occur in the province.

Sweeping activities were, therefore, commenced during the latter part of May, 1937. These yielded such prolific results that they were continued energetically until towards the end of July. A large range of possible food plants was systematically examined and, when possible, records were kept of the plants on which various species were taken.

In a few instances, the presence of immature forms established "host" relationships. More often adults only were taken. When the latter were numerous and could be taken repeatedly from scattered representatives of the same plant though rarely, if ever, from neighbouring vegetation, we feel justified in considering the infested species to be of some biological significance in the life-cycle of the Chermid. Following the terminology of Klyver³, who states that there is no proof that adults ever feed, we are listing these plants as "nominal hosts," though we have no proof that the Chermid in question actually breeds on them. When, as frequently happened, adults were taken singly on plants other than on those on which they obviously congregated it would appear that their presence had no biological significance other than that the plant in question had served as a temporary resting place.

In the following list, therefore, "host" indicates that immature stages were taken; "nominal host" that adults evidently congregate on that particular species, while plants listed as "taken on" are recorded as a possible source of information should further observations suggest a relationship which is not, at present, indicated.

No particular efforts were made to ascertain the effects of the presence of the Chermids on the various plants. Nothing, in particular, was observed

which was attributed to their presence. It is hoped that more complete biological data will be obtainable in future years.

We were most fortunate in obtaining the assistance of Mr. J. S. Caldwell, of the Ohio Biological Survey, who most generously determined our material for us. With the assistance of Crawford's monograph on the Family, Mr. F. O. Morrison, a graduate student at this University, had already attempted to name the species taken. Although his attempts were largely successful, a complete lack of authoritatively determined species in our collection proved to be an insurmountable obstacle against so doing with any certainty.

Mr. Caldwell found that we had taken twenty-five recognized species. Four additional species could not be placed with any certainty until more material is available and Mr. Caldwell states that two of these are, undoubtedly, undescribed. He suggested that we describe these ourselves, which we hope to do in a future article when we are rather more familiar with the taxonomy of the group.

Livinae.

Aphalara artemisiae Forst. Edmonton, Dapp. June to July.

Adults of the species were taken, in relatively small numbers (in comparison with *A. vancouverensis* Kby.) on three species of sage. No immature stages could be found. With reference to the determination Caldwell writes, "This is probably a "composite" species . . . personally I doubt whether *artemisiae* Forst. actually occurs in this country."

Nominal host:—*Artemisia* Spp. (Sage).

Aphalara confusa Cald. Wabamun, Dapp. Lesser Slave Lake, Donelly. June to July.

Adults were taken rather freely on docks in the Peace River District. They appear to be definitely associated with this plant. At Dapp, however, they were taken sparingly on Asters, whereas docks growing in the vicinity were heavily infested, solely, with *A. rumicis* Mall.

Nominal host:—*Rumex* Sp. (Dock).

Taken on:—*Aster* Spp., Rushes and Slough Grass.

Aphalara curta Cald. Beaverlodge.

A single adult was taken, without further data, by I. C. Shanks in 1934.

Aphalara dentata Cald. Medicine Hat. May.

Two adults were taken in 1928 by the late F. S. Carr.

Aphalara loca Cald. Edmonton, Dapp, Donelly. July.

Adults abundant on knotweed growing along infrequently used farm roads in several localities.

Nominal host:—*Polygonum erectum*. (Knotweed).

Taken on:—*Solidago* Sp. (Goldenrod), *Aster* Spp.

Aphalara simila Cald. Wabamun. June.

One specimen, only, was taken in sweeping vegetation by a lake-side.

Taken on:—*Juncus* Sp. (rush).

The preceding five species are members of the complex, formerly referred in American literature to *A. calthae* L., but which have recently been separated by Caldwell⁴, who states that there are no authentic records of the European

calthae occurring on this Continent.

Aphalara hebecephala Cald. Edmonton, Wabamun, Dapp. June to July.

This breeds extensively on fireweed. It was first observed on June 13 at Edmonton. No eggs were found but nymphs were crowded, head downwards, at the base of the leaves. They were all mature, and left the plants, at about the time that the fireweed came into bloom.

Host:—*Epilobium angustifolium*. (Fireweed).

Taken on:—*Chenopodium album* (Lambsquarters), in July.

Aphalara nebulosa kincaidi Ashm. Edmonton, Beaverlodge. June to July.

Adults were moderately common on fireweed which was heavily infested with *A. hebecephala*. No host plant is known for the American variety, but Klyver⁵ states that fireweed is the host of the European variety.

Nominal host:—*Epilobium angustifolium* (Fireweed).

Aphalara rumicis Mall. Dapp, July.

This was very abundant on a patch of dock which was growing on a deserted farm site on the bank of the Pembina River. Elsewhere this weed was infested only with *A. confusa*. Patch⁶ states that the nymphs form pseudo-galls on the leaves of *Rumex*.

Host:—*Rumex* Sp. (Tall dock).

Aphalara vancouverensis Kby. Edmonton, Dapp, Beaverlodge. June to July.

Three species of *Artemesia* were very heavily infested at Edmonton from the beginning of June until observations stopped at the end of July. No immature stages could be found. No eggs were found when the plants were examined in October and a careful examination of plants which were very heavily infested during the previous year was made in May 1938, but no Chermids could be found. By June 26th, 1937, colonies of adults were found on isolated yarrows and related plants. From their abundance, and their scattered incidence, it would appear that they must have bred on these plants even though no nymphs were found.

Nominal host:—*Artemesia* (four) Spp., (Sage), *Achillea lanulosa* and *millefolium* (Yarrow), *A. ptarmica* (Wormseed).

Aphalara veaziei Patch. Edmonton, Donelly, Dapp. June to July.

Regarding this species, Caldwell writes "Probably several species are mixed up here." Adults were taken sparingly (a maximum of about seven to a patch of plants) as listed below. None were found on adjacent vegetation. Klyver³ gives *Solidago* as a host.

Normal host:—*Aster* Spp., *Solidago* Spp.

Triozinae.

Paratriozza cockerelli Sulc. Medicine Hat, Drumheller, Calgary, (Edmonton). January to December in greenhouses, July to September in the field.

Host plants:—Tomatoes, Potatoes, Jerusalem Cherry.

Triozza frontalis sulcata Cwfd. Edmonton, May and September.

Caldwell writes that Oman considers this to be a "good" species. Klyver³ gives *Amelanchier* as a host. Extensive sweeping of Saskatoons in 1937 produced no Chermids but adults are fairly common on them in May, 1938.

Host:—*Amelanchier*.

Trioza maura Forst. Edmonton, Wetaskiwin. May to September.

Caldwell writes that this species is not well-defined and that Chermids, so determined, may belong to more than one species. Various authors give *Salix* Spp. as a host plant. A single adult was taken from potatoes, which were not growing in the vicinity of willows, in September, 1936, and adults are moderately abundant on willows during May and June.

Nominal host:—*Salix* Spp. (Willows).

Taken on:—Potatoes.

Trioza quadripunctata Cwfd. High Prairie, Dapp, Edmonton. July.

Adults were taken, in very large numbers, exclusively on nettles. Crawford states that they hibernate on grass-stems, but gives no host.

Nominal host:—*Urtica procera*. (Nettle).

Trioza (near) *similis* Cwfd.

One adult female, only, taken. No data as to food plant. Caldwell writes that, though this is very like *similis*, it is, apparently, not identical. Crawford records *similis* as feeding on *Amelanchier* Sp. None were taken in Alberta during consistent sweeping of Saskatoons.

Trioza varians Cwfd. Banff, Edmonton, High Prairie. June to August.

Crawford states that this feeds on *Salix* Sp. on which it was taken at Banff. We took it freely from willows growing on sand bars close to rivers but failed to find any on similar bushes if they grew at a distance of more than about fifty feet from the water.

Nominal host:—*Salix linearifolia* (Narrow leaved Willow).

Psyllinae.

Psyllia alba Cwfd. Edmonton, High Prairie. June to July.

Crawford gives *Salix longifolia* as a host. While this Chermid is moderately abundant on willows in Alberta the adults were taken so frequently, and in such large numbers, on asters that some biological significance is indicated.

Nominal hosts:—*Salix linearifolia*, *Aster* Spp.

Psyllia alni americana Cwfd. Nordegg, Athabasca. July.

Adults were abundant on swamp birch at Nordegg in 1936. None could be found on these bushes at Athabasca in 1937, though a few were taken in this locality from alders, which are given by Crawford and Klyver³ as host plants.

Nominal hosts:—*Alnus incana* (Alder), *Betulosa glandulosa* (Swamp birch).

Psyllia americana Cwfd. Banff. June.

This species was described from Banff by Crawford who gives as a food plant, *Pinus* Spp. We have not taken this typical variety.

Psyllia americana flava Cwfd. Edmonton. April to June.

Adults were taken from the surface of a snow-bank in April 1925. A single specimen was captured, in June, without data as to vegetation.

Psyllia (near) *fibulata* Cwfd. Edmonton. June.

Caldwell doubts whether this is a typical *fibulata* which he states is smaller, paler and with more slender genal cones.

Nominal host:—*Salix linearifolia* (close to water).

Psyllia floccosa Patch. Edmonton. June.

Patch⁷, in describing this species from Maine, states that the nymphs, which live on Alders, have a pale green head and thorax, and a yellow abdomen. She states further, that they are covered with white flocculent secretions. Nymphs which we took in association with the adults were destitute of secretions and were green with strongly contrasted black abdomens.

Nominal host:—*Alnus incana* (Alder).

Psyllia hartigii Flor. Edmonton. June.

Crawford states that, in Europe and America, this species feeds on birch. At Edmonton, diligent sweeping of birch yielded nothing except *P. sinuata*, which, though not common, was taken repeatedly on these trees. Two adults of *hartigii* were taken, however, on a very stunted basswood, which was rather heavily infested with *P. striata*. Data were too meagre to suggest a nominal host in Alberta.

Taken on:—Basswood.

Psyllia magnicauda Cwfd. Edmonton. June to July.

Nymphs were common in June on wolf willow. First adults taken on June 22 and they were plentiful throughout July. Klyver³ gives *Prunus?* as a host plant.

Host:—*Elaeagnus commutata* (Wolf willow).

Psyllia negundinis Mall. Edmonton. June to July.

Caldwell writes that our specimens are not quite typical and adds:—"You, at least, have a new variety." Typical specimens are recorded by Crawford as feeding on Manitoba maple. We failed to obtain nymphs.

Nominal host:—*Negundo interius*. (Manitoba maple).

Psyllia sinuata Cwfd. Edmonton, Nordegg. June to July.

Nymphs and adults were taken on small spruces growing under deciduous trees. They could not be found on spruces which grew in the open. Adults were taken, repeatedly, on birch trees growing at a distance from spruces. Although this species was taken on a greater variety of vegetation than was any other, comparatively few specimens were found on anything with the exception of spruce and birch.

Host:—*Picea glauca* (White spruce).

Nominal hosts:—*Betula* Spp. (Birch, including swamp birch).

Taken on:—*Populus tremuloides* (Aspen), *Oxycoccus macrocarpus* (High cranberry), *Quercus* Spp. (Oak), *Salix myrtillifolia* (Myrtle-leaved willow, Laurel leaved willow, tall grass in wood-lands).

Psyllia striata Patch. Edmonton. June.

A number of specimens were taken from a small, stunted, basswood on which, evidently, they congregated. Since this tree is not native to Alberta, and we know of one example only in Edmonton, it probably is not the normal host plant here. Patch⁸ bred this species from birch, but none could be found on this tree in Alberta.

Taken on:—Basswood.

REFERENCES TO LITERATURE CITED

1. Crawford, D. L. Monog. Jumping Plant Lice. U. S. Nat. Mus. Bull. 85. 1914.
2. Sanford, G. B. A Malady of Potatoes in Alta. Sci. Agric. V. 15. p. 46. 1934.

3. Klyver, F. D. Biol. Notes &c. N. Am. Chermidae. Ent. News. V. 43. p. 7. 1932.
4. Caldwell, J. S. Some N. Am. rel. of *A. calthae*. Ann. E. S. Am. V. 30 p. 563. 1937.
5. Klyver, F. D. New Rec. of Cherm. from B.C. &c. Pan-Pac. Ent. V. 8. p. 11. 1931.
6. Patch, E. Notes on Psyllidae. Me. Ag. Exp. Stat. Bull. 202. 1912.
7. Patch, E. Downy Psyllid of Alder. Can. Ent. V. 41. p. 301. 1909.
8. Patch, E. Insect Notes for 1910. Me. Ag. Exp. Stat. Bull. 187. p. 14. 1911.

THELYOTOKOUS PARTHENOGENESIS IN CEPHUS CINCTUS NORT. (HYMENOPTERA: CEPHIDAE).

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The wheat stem sawfly (*Cephus cinctus* Nort.) has recently become established as a serious pest of wheat in the Nobleford—Lethbridge area of southern Alberta, the first appreciable damage to wheat occurring in 1934. Each succeeding year the insect has increased and spread rapidly throughout the area, and in many cases crop losses have run as high as 75 to 80 per cent.

During laboratory investigation in the winter of 1936-37 a complete absence of male sawflies was noticed in all the material collected from fields adjoining Lethbridge. In all other districts where wheat stem sawfly has been established for many years the sexes occur in approximately equal numbers. The lack of males in southern Alberta was tentatively attributed to a differential sex mortality, but since the mortality did not approach 50 per cent, this hypothesis was discarded.

Rearred female *C. cinctus* Nort. were confined over host plants of wheat and brome grass for oviposition and developmental studies. After egg-laying was completed the eggs were removed from the stems and placed in seamless salve tins containing moist blotting paper. This precaution was necessary because cannibalism inside the stems would make an accurate check on hatchability impossible. One hundred and seventeen eggs were secured in this way and 92 per cent of them hatched. It is quite possible that some of the eggs were injured during stem dissection, which might account for the fate of some of the unhatched eggs.

A series of reared female wheat stem sawflies secured from an area where both sexes occur in approximately equal numbers was then placed on wheat plants in an outdoor cage for oviposition. This material was not disturbed until the larvae cut the stems at harvest time. Since these larvae apparently developed normally from unfertilized eggs, it appears as though the males are functionally useless so far as the survival of the species is concerned.

According to Hewitt¹, "The parthenogenetic young are constitutionally weak and may die before obtaining maturity." There is no evidence from either laboratory investigations or field observations of any constitutional weakness in the parthenogenetic progeny of *C. cinctus* Nort. The newly hatched larvae appear normal in every respect, and the adult females have approximately the same number of eggs as those taken from areas where both sexes occur.

A search of the literature failed to reveal similar cases in the *Cephus* group. Correspondence on this subject between Dr. Arthur Gibson, Dominion Entomologist, Ottawa, Canada, and Sir Guy Marshall, Director of Imperial In-

¹Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. 50, Pt. III, 1906, p. 5.

stitute of Entomology, London, England, was referred to Prof. A. D. Peacock, Department of Natural History, University College, Dundee, Scotland. Prof. Peacock in answer to this correspondence stated that cytological studies on the spermatogonia indicated that in all probability the closely related species, *Cephus pygmaeus* L., is arrhenotokously parthenogenetic. He further states, "There is another point that needs to be watched and that is, that in Canada the species may actually be thelytokously parthenogenetic. The case of *Diprion polytomum* Htg. shows that in Europe the species is arrhenotokously parthenogenetic, while in Canada it is thelytokously parthenogenetic (See Smith, NATURE, Jan. 15, 1938)."

The present study indicates that Prof. Peacock's conjecture is correct for *C. cinctus* Nort. Absence of fertilization, that is, parthenogenetic reproduction, in *C. cinctus* Nort. in Alberta appears to produce only females so far as is known at present. The males can probably be produced only from fertilized eggs. Whether or not nutrition has contributed to the complete elimination of the males in any special areas cannot be determined from the present information.

Enormous numbers of adults and hibernating larvae have been collected from this area of Alberta since 1935, but no males have yet been found. During that time, wheat stem sawfly increased at an alarming rate. This is not surprising, since dissections revealed that parthenogenetic females contain as many eggs as those from areas where the insect is bisexual. Thus, the biotic potential of the insect in this particular district is practically double what it is in the areas where both sexes occur.

NEW BIBIONIDAE FROM BRITISH COLUMBIA.¹

BY D. ELMO HARDY,²

Logan, Utah.

The material here described represents three new species and one new variety. These were received by the writer from J. K. Jacob of the University of British Columbia and from D. Denning of the University of Minnesota.

Bibio columbiaensis n. sp.

Figs. 2-6

This species is related to *Bibio fumipennis* Walker but differs in having all tibiae and tarsi darker than femora, and longer inner spurs on front tibiae (figs. 1-2).

Male. Head, thorax (except yellow anterior margin of humeral ridges), coxae, trochanters and abdomen black. Head with dense, long, black hair on the face and copious black pile on the eyes. Ocellar tubercle (fig. 3) strongly developed, higher than that of *fumipennis*. Pile of dorsum of thorax yellow gray with some darker hairs intermixed, some hairs darker at bases. Pile of pleura yellow, that of abdomen dense, yellow gray. All tibiae darker than femora, all femora rufous with black tips. Anterior and middle tibiae rufescent-brown. Under portion of posterior tibiae rufescent with a dark reddish-brown to black stripe running its entire length on the dorsal edge; entire apical one-third to one-half

1. Contribution from the Department of Entomology, Utah Agricultural Experiment Station. Authorized for publication,

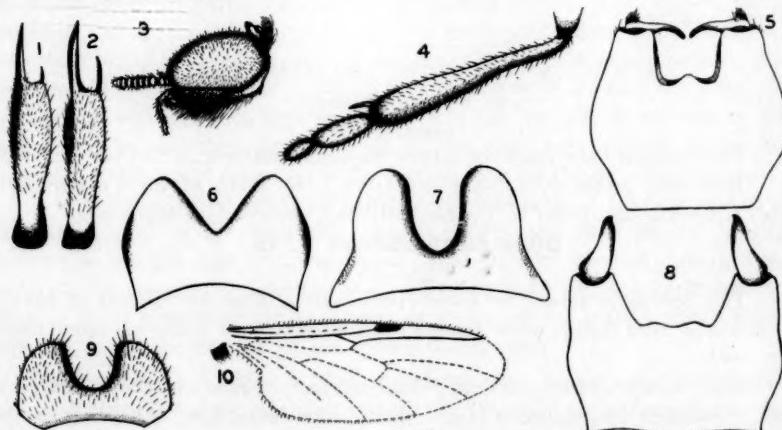
2. Graduate fellow.

of tibiae sometimes reddish-brown to black. Posterior basitarsi enlarged but cylindrical and not globular, other tarsal segments swollen (fig. 4). Front and mid tarsi chiefly black, somewhat yellowed at bases. Posterior basitarsi chiefly yellow, darkened apically, second tarsal segment yellow basally, yellow brown apically, other tarsal segments black. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi yellow red. Wings yellow fumose, somewhat darker costally; r-m crossvein slightly shorter than the basal part of the Rs. Anterior veins and stigmata dark brown, posterior veins yellow brown. Humeral crossvein distinct.

Genitalia. Genital cleft extending but a little over one third the length of the segment. Styli narrow and with distinct tufts of dark hair basodorsally (fig. 5). Superior plate (9th tergite) deeply angulate emarginate, the cleft extending slightly more than half its length; apices obtuse, with edges gently rounding (fig. 6). The ninth tergite of *Bibio fumipennis* cleft over three-fourths its length, the cleft more broad basally and not angulate (fig. 7).

Female unknown.

Holotype, male, Jesmond, B.C., 3-IX-1937 (J. K. Jacob). *Paratypes*, seventeen males, same data as holotype. Type and four paratypes deposited in the Canadian National Museum; four paratypes returned to J. K. Jacob, University of Vancouver; three paratypes in the United States National Museum; two paratypes in the British Museum; and four paratypes in the Utah State Agricultural College collection.



Bibio fumipennis Walker, 1, front tibia; 7, dorsal view of superior plate. *Bibio columbiensis* n. sp., 2, front tibia; 3, lateral view of male head; 4, posterior tibiae and first two tarsal segments of male; 5, male genitalia, ventral view; 6, dorsal view of superior plate. *Bibio jacobi rufitibialis* n. var., 8, male genitalia, ventral view; 9, dorsal view of superior plate. *Bibio conus* n. sp., 10, wing of male.

Bibio conus n. sp.

The species resembles somewhat *B. xanthopus* Wiedemann but differs distinctly in having the r-m crossvein one-half the length of the basal part of the radial sector (fig. 10); posterior veins concolorous with the membrane, and posterior tarsal segments slightly swollen but not approaching in size the end of

the femora and tibiae.

Male. Head, thorax (except yellow humeral ridges) abdomen, coxae and trochanters black. Antennae with eight segments, pile of eyes, occiput, palps and antennae black, that of face dark brown. Thorax rather sparsely pillose, pile of dorsum yellow brown, that of pleura, venter, abdomen (somewhat darker on genitalia), coxae, trochanter and femora yellow gray, with a few yellow-brown hairs intermixed on femora. Pile of tibiae and tarsi yellow to yellow brown intermixed. Front and mid femora brownish-black with a yellow tinge, lighter in the middle and darker on dorsal and ventral edges. Hind femora and all tibiae yellow basally with brown to black tips (tibial spurs rufous), hind femora darkened on apical half. The first two tarsal segments chiefly yellow, the last three chiefly black. Hind femora and tibiae clavate, inner spurs of front tibiae about one-third the length of the outer. Wings chiefly hyaline, very slightly fumose, anterior veins and stigmata dark brown, posterior concolorous with the membrane. Humeral crossvein pale and slightly interrupted just before the costa (fig. 10). Halteres brownish.

Female. The female differs in having the wings yellow fumose, pile of dorsum more yellowed, pleura, coxae, trochanters and labellum with a yellow tinge; legs chiefly yellow to rufous, hind tibiae straight or nearly so, tarsal segments slender, and cerci of genitalia yellowish.

Holotype, male, Churchill, Manitoba, Aug. 2-9, 1937 (R. H. Daggy). **Allotype** female and one *paratype* male, same data as holotype. Holotype and allotype returned to D. Denning, University of Minnesota; paratype to be deposited in the United States National Museum.

Bibio jacobi n. sp.

Species somewhat related to *B. atripilosus* James but differs distinctly in having wings yellow brown fumose.

Male. Head, thorax (excepting yellowed humeral ridges) and abdomen black. Pile of head chiefly black, with some gray hairs on the face, that of thorax and abdomen yellow. Legs chiefly shining black with the bases of the tibiae and basitarsi yellowish, spurs rufous. Anterior femora strongly swollen, inner spurs of anterior tibiae short, approximately one-third the length of the outer. Posterior femora and tibiae clavate. Posterior basitarsi not strongly swollen and rather elongate, twice as long as second tarsal segment. Pile of coxae, trochanters and femora yellow, that of tibiae and tarsi chiefly brown to black. Wings yellow brown fumose, r_m crossveins equal in length to the basal part of the radial sector. Posterior veins and stigmata brown, anterior veins yellow to yellow brown. Humeral crossvein obsolete and interrupted, being but a short pale stump arising from the subcostal vein.

Female unknown.

Holotype, male, Dunn Pk., B.C. 9-VIII-1937, 8,500 ft. (J. K. Jacob). Deposited in the Canadian National Museum.

Bibio jacobi rufitibialis n. var.

Figs. 8-9

Male. Differs from the type species in having the base of the femora rufous with the apices brunneous and the tibiae and first two to three tarsal seg-

ments chiefly rufous.

Genitalia. Ninth sternite rather broad, cleft of segment about one-third its length, claspers rather elongate and pointed on apical, inner edges (fig. 8). Superior plate cleft about two-thirds its length, the cleft rounding (fig. 9); pile of genitalia brown to black.

Holotype, male, Dunn Pk., B.C. 9-VIII-1937, 8,500 ft. (J. K. Jacob), deposited in the Canadian National Museum.

STUDIES ON THE BIOLOGY OF THE EPHemeroptera. I. COLORATION AND ITS RELATION TO SEASONAL EMERGENCE.*

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The following observations and conclusions are based upon ephemerids from temperate North America and principally upon material from the eastern United States. It is perfectly conceivable that in other parts of the world, where the fauna and also the environmental conditions are different, the conclusions reached here may not be applicable.

Colors in species of this order vary from white through yellow, orange, red (a few subdued reds), brown to black. The commonest colors are the browns, especially various dark browns. A few species have pale greens, but these are evanescent. There are no bright greens, blues or reds. In other words, the bright metallic colors found in some of the Odonata, Coleoptera and the Lepidoptera are lacking. A survey of the whole order shows that there are few bright colored ephemerids. Most of them are distinctly drab and the colors are usually dull and subdued. This is especially true of the more primitive species.

It is necessary to digress briefly concerning the question of primitive and specialized genera and species. By primitive, it is not assumed or meant that such groups are primitive in all characters and, conversely, by specialized it is not to be taken that these groups are specialized as far as every character is concerned. What is meant is that the sum total of all nymphal, subimaginal and adult characters indicates that the particular genus or species is more primitive or more specialized than other genera or species that it can be compared with. Naturally the conclusion as to whether a character is specialized or primitive is determined by studying it in numerous extant species as well as from the fossil evidence. Thus a species or a genus may be primitive in most characters but specialized in others. After all, a good many million years have intervened between the modern forms and the ancient ones, and the surprising fact is that any stock should still possess primitive characters after so many countless generations.

DISTRIBUTION OF COLOR IN IMAGO

By carefully clearing away all tissue that underlies the exoskeleton, it is easily proved that in the greater number of species of ephemerids the entire exoskeleton is transparent. If color is present in the chitin, it always is some shade of olive brown. Often the exoskeleton is similar to smoked glass, i.e., transpar-

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ent with a variable amount of brown. In some instances, such as the mesothoracic notum of *Leptophlebia cupida* Say and *Paraleptophlebia* spp., the brown pigment is so intense that the chitin is almost opaque. Invariably, if color is present, it is most intense on the thoracic nota. It also is rather evenly distributed throughout the entire exoskeleton, and as a result is not responsible for sharp, clear cut color patterns. Sometimes in connection with the underlying colors, it forms the typical color pattern as in *Leptophlebia cupida* Say and *Hexagenia* spp. In *Isonychia bicolor* Wlk., however, the chitin is faintly tinged with a brown color which is completely, or almost completely, masked by the underlying red color.

The tissues immediately underlying the exoskeleton are often impregnated with pigments of some sort which are mainly responsible for the distinctive color patterns of most species. The dark color patterns of the abdomens of the members of the genus *Stenonema* as well as other characters such as the banding of the femora are due to these underlying colors. Likewise the red color of *Isonychia bicolor* Wlk. is found in the tissues that underlie the chitin.

The underlying colors, as well as the various shades of brown found in the exoskeleton, are not destroyed by drying or immersing in preserving fluids. Probably they are of protein origin.

The white colors found in ephemeroids are caused by two distinct factors:

1. In all adults there is present, underneath the chitinous exoskeleton and the epidermis but external to the musculature, a chalky white substance. This is localized mainly in the last three abdominal segments, the vertex of the head, and the sutures and articulating membranes of the thorax. There is considerable individual and specific variation in the distribution of this substance, and one may expect to find it underlying almost any part of the exoskeleton except the places where the muscles themselves are attached. Since the musculature of the adult is greatly reduced, this allows for a wide distribution of the substance. Just what the nature of the substance is, I can not say. It is, however, easily shown that it does not have the same refractive index as chitin. Probably it is a by-product of the degeneration of the digestive tract and musculature of the nymph that takes place just previous to emergence. If the substance underlies a transparent area of the exoskeleton, it gives that region an alabaster white appearance. It also forms combination colors where the overlying chitin or epidermis is pigmented. In combination with some browns it results in oranges, yellows, rusts, etc. It is important to note that this type of white is present in the dark species such as members of *Siphlonurus* and *Parameletus*, but is completely masked by the dark overlying pigments.

2. Certain species such as *Ephoron album* Will., the various species of *Campsurus* and *Potamanthus* and the abdomen of *Ephemera guttulata* Pict., have a milky appearance which is found not only on the body but also on the wings of some species. This is definitely a physical color. If these specimens are immersed in a medium having a refractive index of 1.55 to 1.6, the white areas become transparent and lose their white color. If removed from the medium, they immediately regain their color. Since the chalky white substance is present in all specimens, it is not surprising to find that the two types of white combine to

help form the typical color pattern. Thus in the males and spent females of *Ephemerella guttulata* Pict., the white of the last three abdominal segments is due to chalky substance, while that of segments 2-6 is a physical white. In the unspent females, the egg mass obscures this effect to some extent.

In addition there are some oranges, bright yellows and greenish yellows present in some species. They are mainly restricted to the large dorsal compound eyes and the egg masses. Invariably they are completely or almost completely destroyed by immersion in preserving fluids. To a lesser extent they also deteriorate in dried specimens. These particular pigments are probably chlorophyll derivatives.

It should again be emphasized that great areas of the exoskeleton of many species are transparent. In numerous other cases the chitin has brown pigments present in it but is still semi-transparent. In such cases the color of the underlying tissues or deposited materials enters into the make-up of the color of a particular area. In *Potamanthus myops* Walsh, for example, there are ferruginous markings on the head, the abdomen, tips of the leg joints, and the joinings of the caudal appendages. Such markings are due to pigment in the chitin. About 85 per cent of the body is covered by transparent chitin and derives its color, if any, from the underlying materials, especially muscles as in the thorax and the physical and chalky whites mentioned above.

In other instances, as in species of the genus *Stenonema*, some of the rufous colors are due to the chalky white substance underlying semi-transparent chitin that is impregnated with a light brown pigment.

Most mayfly color patterns are consequently due to a combination of various types of colors.

COLOR PATTERN

Besides actual colors, it is also necessary to consider the color pattern. The latter appears to have developed from a segmental plan in which each segment possessed the same pattern. The fusion of the head and thoracic segments have obscured the segmental nature of the pattern in these areas, but the abdomens of many species show it quite distinctly.

What the coloration of ancient mayflies was, we do not know, but judging from primitive genera such as *Siphlonurus* and *Ameletus* they were probably colored some dark shade of brown and the general pattern of the abdomen gave an annulate appearance. The wings were probably for the most part hyaline, with dark venation. Quite possibly, the base of the wing membranes in some species was tinted brown. The legs, genitalia and caudal filaments were a brown color similar to that of the body proper. The two sexes had a similar coloration.

From such a generalized condition there have been three distinct trends in ephemerid color evolution:

1. The pigments are fairly uniformly distributed over the body of the insect so that the specimen appears an even dark hue. Such a condition is characteristic of most species of the genus *Choroterpes*, of *Leptophlebia cupida* Say and of *L. nebulosa* Wlk., as well as many species of other genera such as *Ironopsis*, *Rhithrogena*, *Isonychia* except for the legs, *Habrophleboides* and *Parameletus*.

2. The cuticular pigments are greatly reduced, sometimes almost lacking, over the entire body. In such instances the color is dependent upon the underlying tissues and often the specimens appear very light. In extreme instances, the individuals appear almost white. Such darker pigments as are present are restricted to the dorsal surfaces of the body, especially the dorsum of the thorax, the last three tergites of the abdomen, the head—particularly the compound eyes, and the longitudinal wing veins. Extreme examples of this type of modification can be found in *Campsurus*, *Ephoron*, *Pentagenia*, *Caenis*, *Oligoneuriella*, and *Potamanthus*. Less extreme cases are the pulchellum complex of *Stenonema* and the invaria complex of *Ephemerella*. There are all degrees of intergradation between the primitive coloration and the highly specialized types as exhibited by *Campsurus*.

3. A large number of species display what can be called the baetid type of coloration, where there is a clear-cut sexual dimorphism in regard to color. In the males the pigmentation is completely lacking from some areas, while other parts are heavily pigmented. It should be remembered that just previous to emergence time and also to some extent during the subimaginal period, extensive changes take place in the digestive system of the ephemerids. The changes result in the mesenteron being converted into a thin-walled, transparent air bladder. Such changes are not restricted to the digestive tract and, in many instances, all the muscles of abdominal segments 2-7 entirely disappear. There is considerable individual variation in such degeneration of the abdominal muscles, so that some individuals possess underlying muscle tissue in these abdominal segments while other members of the same species, collected from the same nuptial flight, completely lack it.

In the males of many species of *Paraleptophlebia*, *Baetis*, *Pseudocloeon*, *Cloeon*, the head, thorax and the last three or four abdominal segments are deeply pigmented, while the wings, abdominal segments 2-7, the caudal filaments and the legs are hyaline. In other species, such as *Cinygmulia atlantica* McD., *Paraleptophlebia bicornuta* McD., *F. heteronea* McD., and *Habrophlebia vibrans* Need., the pigments are deposited in a definite pattern in the abdominal segments so that the abdomen appears only semi-transparent.

The wings, legs, and caudal appendages of the females are pigmented similarly to those of the males, but the entire body is uniformly pigmented and lacks all transparent areas.

COLORATION OF THE SUBIMAGO

Any consideration of ephemerid coloration would be incomplete without mentioning the subimago. This invariably presents a dull, soft opaque appearance. In the air the living individuals are invariably entirely opaque. The difference in texture between a subimago and imago is similar to the difference between a matte and a glossy finish in photography.

The pellicle that is shed by the subimage varies from white in some species to a blackish grey in others. If one of the white but opaque casts, as in *Potamanthus myops* Walsh, is placed in a medium that has the same refractive index as chitin, it immediately becomes transparent. The same thing happens with the grey pellicle of other species such as *Leptophlebia cupida*, Say except

that a rather uniformly distributed melanistic pigment is clearly evident. Thus the actual opacity of the subimago is due to physical effects, but there are often pigments involved which result in combination coloration.

There are a few species, for example *Baetisca obesa* Say, where the subimago has a color pattern somewhat different from that of the imago due to the deposition of dark patches of pigmentation in the subimaginal cast. Usually this is not the case and any pigmentation that is deposited in the subimaginal pellicle is uniformly distributed.

EMERGENCE TIME

In the region of New York City, the earliest species to emerge is *Leptophlebia cupida* Say, whose adults appear in early April. The latest species, or in some instances the second generation of some of the early emerging species, have adults appearing in late October and early November. *Paraleptophlebia debilis* Wlk. is an example of a late season emerging type. Most of November, all of December, January, February, and March are without the emergence of a single species.

The peak of emergence, so far as number of species is concerned, arrives in late May and early June. By the end of June, the number of species emerging is very small and continues so throughout the remainder of the emergence season. In northern latitudes, the emergence period is shorter and the peak of emergence is later. At Churchill, Manitoba, *Leptophlebia nebulosa* Wlk. emerges about the first of July. This species is the northern relative of *L. cupida* Say and in the southern part of its range is found in the same area as *L. cupida* Say and emerging at the same time. It is well to remember that it is the rate of development of the nymph that determines when the imago shall emerge. Development seems to be entirely dependent on the water temperatures.

The relation of rate of development to temperature explains the fact that in the western part of North America, where large streams are fed by huge melting snow fields high in the mountains, that the swiftly flowing streams are cool even after they reach the hot plains, and as a result the peak of emergence is late in the summer, i.e., late July and August.

In the southern part of the United States, the length of the emergence period of the group is much longer. There seems to be no reason why in the tropics and subtropics there should not be some species emerging during each month of the year. As far as I can determine from published records, this is true.

Regardless of the time of emergence during the year, each species has a definite limited period of emergence. In those species which have more than one generation each year, naturally there is more than one emergence period. Usually the period of emergence is relatively short. There are some species, however, such as *Stenonema tripunctatum* Banks and *Isonychia bicolor* Wlk., which emerge during the entire summer. These are the exceptions and not the rule. Ide, in his splendid paper dealing with temperature and the distribution of the mayfly fauna in a stream system, has definitely shown that in the upper part of a stream where the water temperatures were lower and more uniform than the

period of emergence for a particular species is much longer than it is for the same species further downstream where the water temperatures fluctuate much more and are much higher during spring, summer, and fall. Thus there is considerable variation as to the length of emergence time of a single species at different levels within a single stream system. For a fuller discussion of the subject of temperature, the reader is referred to Ide's paper (Univ. of Toronto Studies, Biological Series, No. 39: 3-77).

SEASON OF EMERGENCE AND COLOR

In the eastern part of the United States on the latitude of New York City, the first species to emerge in the spring (late April and early May) are *Leptophlebia cupida* Say, *Paraleptophlebia adoptiva* McD., and *Baetis frivulus* McD. In the southern part of its range, *Leptophlebia nebulosa* Wlk. also emerges at the same time. All of these species emerge before the deciduous trees have leafed out. All have dark venation, dark bodies and appendages. Before they have finished their emergence periods and before the leaves of the deciduous trees have reached full size (middle-two-thirds of May). *Ameletus ludens* Clem., *Iron pleuralis* Bks., *Siphloplecton basale* Clem., *Collibaetis americanus* Bks., and *Ephemerella subvaria* Wlk. appear. These latter species are also all darkly colored. At the end of this period, the first representatives of the genus *Stenonema* are to be found, i.e., *S. vicarium* Wlk., *S. pudica* Hag., and, in areas where the streams flow through limestone country, *S. femoratum* Say. These likewise are all dark colored species.

During late May and all through June, a host of species of various genera appear in great numbers, led by species of *Isonychia*, *Iron*, *Stenonema*, *Ephemera*, *Ephemerella*, *Paraleptophlebia*, *Baetis*, *Cloeon*, *Pseudocloeon*, *Baetisca*, *Siphlonurus*, *Heptagenia*, and *Cinygmulia*. Many of these are heavily pigmented with dark pigments. It is of interest, however, that the close relatives of those species which emerged earlier in the season are much lighter. Thus, *Leptophlebia johnsoni* McD. is lighter than *L. cupida* Say or *L. nebulosa* Wlk.; *Collibaetis ferrugineus* Walsh than *C. americanus* Bks. *Iron humeralis* Morg. and *I. suffusus* Trav. are lighter than *I. pleuralis* Bks.; *Ephemerella invaria* Wlk. and *E. rotunda* Morg. than *E. subvaria* McD.; while *Stenonema vicarium* Wlk., *S. pudica* Hag. and *S. femoratum* Say are darker than any other known species of the genus. *Ameletus ludens* Clem. and *Siphloplecton basale* Clem. have no close relatives. In the cases of *Paraleptophlebia adoptiva* McD. and *Baetis frivulus* McD., we find that the relatives which emerge later are not only lighter in their venation, legs and caudal appendages but, in the case of the males, abdominal segments 2-7 are light, often being transparent or semi-transparent.

A further inspection of the various genera shows that, where there is a genus that has species emerging throughout the season, the earliest species to emerge is darker than species which follow later. Thus, in the pulchellum group of *Stenonema*, *S. vicarium* Wlk. and *S. pudica* Hag. are darker than all later forms of which *rubromaculatum* Clem., *ruber* McD., *pulchellum* Walsh, *bipunctatum* McD., and *mediopunctatum* McD. are examples. In the tripunctata complex of the same genus, *femoratum* Say is darker than *tripunctata* Bks., while again in the same genus in the interpunctata complex, *canadense* Wlk. and

gildersleevei Trav. are darker than any other species in the group. In the *invaria* complex of *Ephemerella*, *E. subvaria* McD. is darker than any other species of the same complex. *Subvaria* McD. is followed by *invaria* Wlk. and *rotunda* Morgan which are in turn much darker than *dorothea* Need. which follows still later. Turning to *Paraleptophlebia*, we find that the early eastern *adoptiva* McD. is darker than any other eastern species that emerges later. Finally, still later in the season, July and August, there emerge those forms which are almost completely light, such as *Potamanthus*, *Caenis*, *Ephoron*, and, in the middle of the United States, *Campsurus*.

There are, of course, exceptions to this generalization. The exceptions can be divided into three categories: (1) the primitive genera such as *Siphlonurus*, all species of which emerge during a rather short period and are dark; (2) certain genera such as *Hexagenia*, *Choroterpes*, *Habrophlebia*, *Habrophleboides*, *Cinygmula*, *Rhithrogena*, *Ironodes*, *Ironobis*, and *Tricorythodes*, the species of which are all dark with few exceptions; (3) sections of large genera such as *Ephemerella* and *Ephemera*. Thus the *fuscata* and *bicolor* groups or complexes of *Ephemerella* are exceptions but the *E. invaria* group as shown above does fit into the generalization. It should be noted that the *E. invaria* group seems to be the most primitive in the genus. In *Ephemera* both *E. blanda* Trav. and *E. varia* Etn. which emerge later than *E. simulans* Wlk. are pale colored species but *E. guttulata* Pict. emerges as early as or earlier than *E. simulans* Wlk. and is decidedly white except for the thorax, head, and certain other areas.

Before attempting to determine the reasons involved in this distribution of color patterns throughout the group, it is necessary to consider the daily emergence and mating time of the various species.

Those species which emerge in the early part of the season invariably do so during the daytime, and likewise the nuptial dance occurs during the day. As the season progresses, there is a tendency to push the emergence time toward late evening so that, from the early part of June, many species tend to emerge at night.

In the case of the nuptial dance, there are two tendencies:

1. Most of the species and especially those that have large individuals, such as the members of *Stenonema*, *Heptagenia*, and *Hexagenia*, and those that are completely light (*Potamanthus*, *Caenis*) tend to have the nuptial dance at dusk or even still later at night. The apex of such development is reached in such genera as *Ephoron* which emerge after dark, immediately mate and die before morning. In a sense this form is almost similar to a cave animal since the nymph is a burrower and thus is not exposed to the light, and since the subimago and imago never see the light.

2. Many species of the genera *Paraleptophlebia*, *Habrophlebia*, *Baetis*, *Cloeon*, *Pseudocloeon*, and *Centroptilum* engage in nuptial flight during the day. Individuals of these genera are small. They have transparent legs, wings, and caudal appendages in both sexes, and also the abdominal segments 2-6 in the males are transparent. Anyone who has observed these species in nuptial flight knows how extremely difficult it is to see the male individuals in flight. The females are somewhat easier to locate because of their dark abdomens. The

latter, however, enter the nuptial flight only long enough to copulate with a male and then immediately leave to lay their eggs. Thus they are exposed only a short time to their predatory enemies, of which the insectivorous birds are unquestionably the most dangerous.

In attempting to analyze the causes concerned with the tendency for early season species to be dark and their later relatives to be light, *Stenonema tripunctata* Bks. furnishes us an excellent clue. This species spreads its emergence period over several months, starting in late April and extending into September. The first individuals to emerge are very dark all over, while those that emerge in August are much lighter. In fact, some of the latter are almost white. The only answer that seems feasible is that those forms which reach maturity in the spring while the water temperatures are low have more melanin deposited in their chitin and epidermis than those that reach maturity while the water temperatures are higher. This is in accord with the known facts that the optimum temperature for the formation of melanin from tyrosin is 10° C. Thus, in the various series discussed above, it may simply mean that those species that develop under colder temperatures tend to deposit more melanin in the chitin and the underlying tissues of the imago than do those that develop under warmer conditions.

The really crucial question is what makes it possible for one species to reach maturity while the water temperature is low, while the nymphs of another species living in the same stream and under the same environmental conditions must await warmer weather before they can reach maturity. The dark pigmentation of the early forms unquestionably seems to be of some survival value to the individuals, since they emerge and engage in the nuptial dance during the day and are thus exposed to the major enemies of all mayflies, i.e., birds, dragonflies, and a few other carnivores. Under such conditions, light colored individuals would be at a considerable disadvantage. When the lighter colored species do emerge, it is invariably at warmer periods and the individuals emerge mainly at night and engage in the nuptial dance at twilight. It does not seem logical to assume a direct causal connection between the dark coloration as a protective adaptation and time of emergence. All of the early emerging species belong to specialized genera. The more primitive genera emerge later in the season. The various early emergents must therefore possess a physiological make-up that will allow the nymph to reach maturity while the water temperatures are low. Development under a lower temperature in turn probably facilitates the deposition of dark pigments in the resultant imago, and merely as a secondary result the dark coloration apparently is of survival value. In fact, as is easily observed, any species that emerges during the day, no matter how colored, invariably undergoes considerable decimation by winged enemies as subimagoes leave the water and fly toward the vegetation surrounding the body of water in which they dwelt as nymphs.

In *Baetis* and its relatives and in the majority of the species *Paraleptophlebia* however, with the small size and the distinctive distribution of the dark pigmentation to those parts of the body which are underlaid mainly by muscle tissue, there seems no logical way of explaining the phenomenon except by assum-

ing that the color pattern has arisen as a direct result of its survival value. Should the entire exoskeleton be transparent, then the light colored muscles as well as light colored egg masses of the females would show through and thus render these specimens highly conspicuous. As it is, the wings, legs, caudal filaments and, in the males, abdominal segments 2-6 are transparent and thus in the flying insect almost invisible, while the dark areas, being small, are relatively inconspicuous. It should be noted that despite the fact that many of these species reach maturity in and emerge from warm water, nevertheless many of them have certain areas in which melanin is abundantly deposited.

In conclusion, it might be pointed out that, no matter what the coloration or color pattern of any ephemerid may be, it tends to make the individuals of that species inconspicuous in the particular set of environmental conditions where they normally spend their brief adult life spans.

BOOK REVIEWS

Insects of Citrus and Other Subtropical Crops. By H. J. Quayle. Comstock Publishing Company, Ithaca, N.Y. 1938. 583 pages, 377 illustrations. \$5.00.

In this book, in keeping with most texts on economic entomology, after the introductory chapter, the biology and control of the insects are treated in accordance with the different crops. The insects attacking the main crop, Citrus, are further divided into major and minor insects. Four chapters, in all 320 pages, deal with citrus insects. The insects attacking avocado, vinifera grape, Persian walnut, almond, pecan, fig, olive, date, and oriental persimmon, pomegranate, and sweet cherry are each dealt with in a short chapter. Rodents, nematodes and snails are also treated briefly. Two chapters (about 100 pages) are devoted to fumigation, spraying and dusting. The last chapter summarizes domestic plant quarantines in the United States relating to subtropical fruit insects.

The author of this book has spent thirty years, three of them abroad, in the study of subtropical fruit insects. Since the predominant subtropical fruit, citrus, occurs in restricted climatic zones, and the insect fauna is more or less similar, the author has felt justified in disregarding geographical limits and making this book the first comprehensive text in this field.

Although the subtropical fruit industry is not a problem of vital interest to most entomologists, it is, however, a field which should serve as a source of inspiration and ideas to entomologists in other lines of investigation. The nature of the industry, its rapid expansion under moderate climatic conditions, the introduction of new species of insects and the change of habit of some of the old species, even to change in tolerance or resistance to methods of treatment, have necessitated a continuous modification of the general method of control. These general methods of control are well exemplified in Dr. Quayle's book, particularly the adaptation of fumigation for field control and the biological method.

Les Animaux Ennemis de nos Cultures: Procedes de Destruction. By Professor A. Guillaume (a la Faculte de Pharmacie de Strasbourg). Vigot Freres, Paris (VI). 328 pages, 124 illustrations. 1938. 70 fr.

This volume has been prepared largely as a guide to "dispensing chemists" and agricultural instructors, in their efforts to control various animal pests of

plants. A little more than the first half of the book is devoted to the biology and control of insects (and some Acariniids), arranged according to their zoological position instead of according to the plant attacked as in most references of this type. This is followed by sections dealing with mechanical, physical, cultural and biological control and insecticides; sprayers and dusters; and regulations for the use and sale of insecticides. About fifty pages are devoted to the biology and control of non-arthropod pests such as molluscs, rodents and crows. The last few pages contain a proposed organization of control measures.

Although this book is not as comprehensive as many American texts, it is, nevertheless, of considerable interest as an index to the control measures employed in a country where agricultural practises are quite different from those in America.

Traite D'Entomologie Medicale et Veterinaire. By M. Neven-Lemaire. Vigot Freres, Paris. 1339 pages, 597 illustrations. paper cover. 250 fr.

This, the second volume in a series of three devoted to medical and veterinary zoology and parasitology, deals with the "Arthropodal" aspect of the subject. The first volume was devoted to Helminthology and the third will deal with Protozoology.

In the compilation of this volume the author has had reference to numerous original papers and to the extensive library of the Faculty of Medicine of Paris. Throughout the work he has endeavoured to make it as comprehensive as possible and in order to accomplish this practically all arthropods of medical or veterinary significance have been at least mentioned if not dealt with at length. As in most compilations of this nature, some details of interest have been omitted, and the majority of the figures are reproductions of figures which have appeared in other works, some of which could undoubtedly be improved. Unfortunately, probably due to the size of the volume, the bibliography of 6 pages has been largely confined to the principle general works on the subject and to complete monographs on the arthropod groups. There is a general index of forty-four pages.

The volume is divided into four parts, of which the first is really a general introduction to parasitology. As such it includes such subjects as modifications of arthropods to a parasitic mode of life; degrees of parasitism; organs affected; means of access and egress; migrations; hosts and parasite reactions; vectors; intermediate hosts; the role of arthropods in medicine; and distribution.

The second part, titled "Special Entomology," following the zoological sequence, deals with the arthropods of medical and veterinary significance amongst which are included many forms affecting wild animals. Thus amongst the Crustacea some Cladocera, Ostracoda, Copepoda, Amphipoda, Isopoda, and Decapoda are briefly discussed, as well as some members of the Pentastomida and the Myriapoda.

The main body of this part of the work deals with the Arachnoidea, occupying about 380 pages, and the Insecta, occupying about 660 pages. In these groups, where possible, the species are discussed under synonymy, morphology, habitat, biology, geographical distribution, and their role as pathogens. Many of the diseased conditions produced by arthropods are treated at length under such headings

as symptoms, pathologic anatomy, etiology, diagnosis, treatment and prophylaxis. In the connection with the more important genera, identification tables have been included.

The last two parts of the volume are designed to form a handy reference to parasitology. Part three consists of a list of the hosts of parasitic and commensal arthropods, with the parts affected. Part four consists of a list of the parasites and pathogens and the arthropods which are the hosts or vectors.

To round out the work and take care of a group which would otherwise be omitted in the three volumes of the series the author has included the annelid parasites in an appendix.

Entomologists or Zoologists whose work is at all connected with parasitology should find in this volume a source of readily available information.

REG. H. OZBURN.

SEVENTY-FIFTH ANNIVERSARY OF THE ENTOMOLOGICAL SOCIETY OF ONTARIO.

The Seventy-fifth Anniversary Meeting of the Entomological Society of Ontario will be held at the Ontario Agricultural College on Thursday and Friday, November 24th and 25th, 1938. If the programme warrants it, the Meetings will be continued on Saturday, November 26th.

For the convenience of members of the Society and visitors, the Meetings are being held immediately following the Royal Winter Fair, thus affording a good opportunity to visit the Fair on the way to the Meetings.

Titles of papers should be in the hands of the Secretary by November 12th. Those presenting papers are urged to prepare an abstract, or to be prepared to give the substance of the paper orally (time not exceeding 10 minutes) and thus allow time for discussion. Please advise if a lantern is needed.

Since this is the Seventy-fifth Anniversary, the Council and Local Committee are making every effort to make the Meetings an outstanding success.

Special provision is being made for entertainment of Ladies who may accompany members or visitors.

Please make a special effort to be present and help maintain the high standard of our Meetings.

Dr. Arthur Gibson, President, Division of Entomology, Science Service, Department of Agriculture, Ottawa.

R. H. Ozburn, Secretary, Department of Entomology, Ontario Agricultural College, Guelph.

Local Committee: Prof. A. W. Baker, Chairman; Prof. L. Caesar, R. W. Thompson, R. H. Ozburn, Secretary.

Mailed Saturday, November 5th, 1938.